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Abstract: INTRODUCTION In recent years, the importance of income from broadcasting rights for professional sports clubs' revenues has increased significantly both in the U.S. and in Europe [see Cave and Crandall, 2001]. While up to the 1980s gate receipts have constituted the major pillar of revenues, this role has since been taken over by income out of broadcasting rights sales [Andreff and Staudohar, 2000].

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A MODEL OF SPORTS BROADCASTING RIGHTS SALES

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INTRODUCTION

In recent years, the importance of income from broadcasting rights for professional sports clubs' revenues has increased significantly both in the U.S. and in Europe [see Cave and Crandall, 2001]. While up to the 1980s gate receipts have constituted the major pillar of revenues, this role has since been taken over by income out of broadcasting rights sales [Andreff and Staudohar, 2000]. The broadcasting rights for Germany's Soccer Bundesliga have recently been sold for an annual fee of €430 million of which the exclusive rights for live coverage of the games amount to €250 million. However, there exists a fundamental difference in sports coverage between the U.S. and Europe. While in the U.S., similar and higher fees are paid in order to seize rights to televise games live, the vast majority of European networks obtaining national soccer broadcasting rights do not show them on free-to-air but on subscription-TV. In the U.S., the rights for the National Football League (NFL) have been acquired by CBS, a national free-to-air network, for $2.2 billion per year. Similarly, even though the values of broadcasting rights for the National Basketball Association (NBA) and Major League Baseball (MLB), which amount to $765 million and $559 million, respectively, are higher than those of most European yearly events, these sports are broadcast on free-to-air- or on cable-TV [Staudohar and Dworkin, 2002; Martzke, 2002]. Cable-TV stations differ from pure subscription-TV stations in that they are primarily financed through advertising even though consumers need to pay a—rather small—fee when subscribing to cable networks while subscription-TV stations are usually commercial-free and financed through the subscription fees. Note that this distinction is to some extent arbitrary. This is due to the fact that some European free-to-air networks are primarily financed by a mandatory fee similar to a lump sum tax and the fact that some subscription services (e.g., NFL Sunday Ticket) are airing commercials. However, as Hoehn and Lancefield [2003] show, there is a

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rather large difference between cable- and direct-to-home subscription fees both in Europe and in North America. Secondly, non-home-owners in some European countries usually pay their cable-TV fees implicitly via their rent, leaving them with no choice other than subscribing to the cable packages. Similar considerations might apply to the U.S. where cable-TV enjoys a TV-household penetration of nearly 90% [Hoehn and Lancefield, 2003]. For these reasons, free-to-air and cable-TV networks will subsequently be subsumed under the term "free-TV" while subscription-TV and pay-per-view will be referred to as "pay-TV". Alternatively, one could also interpret cable as pay-TV and then argue on the grounds of free-to-air TV only. Adopting this viewpoint, there is still a significantly larger amount of live sports on free-TV in the U.S. as opposed to Europe.[1] In what follows, the original distinction between free- and pay-TV will be upheld throughout the paper, noting that this distinction is also in line with the literature [see Spence and Owen, 1977; Chae and Flores, 1998; Choi, 2006].[2]

Table 1 provides an overview of North American and European Sports Leagues broadcasting characteristics and illustrates the discrepancy between free- and subscription-TV airings across the continents:

TABLE 1
Selected Sports Rights and Broadcasters

Country	Sport	Annual Contract Fee	Primary Live Broadcaster(s)
U.S.	Football (NFL)	$2.2 billion (1998-2005)	CBS (f)
U.S.	Basketball (NBA)	$765 million (2002-2007)	TNT (c), ESPN (c), ABC (f)
U.S.	Baseball (MLB)	$559 million (2001-2006)	Fox (c)
Germany	Live Soccer (DFL)	€250 million (2006-2009)	Arena (s)
Germany	Live Soccer (UEFA CL)	€100 million (2006-2009)	Premiere (s)*
U.K.	Live Soccer (Premier League)	£370 million (2001-2004)	BSkyB (s)
U.K.	Live Soccer (UEFA CL)	€130 million (2003-2006)	BSkyB (s), ITV (c)
France	Live Soccer (Ligue 1)	€600 million (2005-2008)	Canal Plus (s)
Italy	Live Soccer (Serie A)	€488 million (2005)	Sky (ppv), Mediaset (ppv)

f = free-to-air, c = cable, s = subscription, ppv = pay-per-view, CL = Champions League
Source: Hoehn and Lancefield [2003], Staudohar and Dworkin [2002], own calculations from newspapers.
* is obliged to show small amount of live games on free-TV.

Even though there are subscription based TV-networks in the U.S. which possess rights to broadcast some selected sports events (DirecTV and DISH) their penetration remains somewhat limited.[3] Conversely, there is some free-TV live sports broadcasting in Europe. However, as Table 1 shows, broadcasting of the major European national soccer leagues has fully migrated to pay-TV. The European Football Association (UEFA) pursues a slightly different strategy with its prestigious pan-European UEFA Champions League. While the majority of rights are sold to subscription-TV stations (Premiere in Germany, BSkyB in the U.K.) there is a minimum amount (in Germany one game per match day) which has to be aired on free-TV channels. Nonetheless, it is fair to say that major sports broadcasting in the U.S. and in Europe differ significantly in terms of the type of channel covering the live event. The question which then arises is why North American Major Leagues tend to sell their broadcasting rights to free-TV networks while their European counterparts by and large prefer pay-TV networks. If the preferred network is chosen by the maximum bid only, then the answer is simple. However, on the one hand, it is questionable if the networks' willingness to pay is

the only determinant and, on the other hand, if this were the case, one must ask the question why free- and subscription-TV networks seemingly differ in their bidding power across the two continents.

Szymanski [2003] [quoted in Hoehn and Lancefield, 2003] has provided several arguments that help answering the questions posed above. He claims that the existence of more than one major sport in the U.S. (as opposed to Europe where soccer is by far the biggest sport in terms of viewer ratings) leads to more conservative pricing on behalf of the TV-networks, that is, a higher amount of sports broadcasting on free-TV. Secondly, the larger U.S. market implies that the national free-to-air networks profit from economies of scale that their European counterparts do not have due to the mainly national character of European broadcasting markets as a consequence of linguistic, cultural and legal barriers. Thirdly, he predicts that subscription-TV will play a more important role in the U.S. in the future since legislation in the U.S. "has been relatively slower to allow entry in the U.S. pay-TV market [Hoehn and Lancefield, 2003, 558]."

Intuitively, one might think of two additional factors contributing to the predominance of pay-TV in Europe as opposed to North America. Firstly, one could argue that the system of promotion and relegation, as it is prevalent in Europe, implies an additional contest to the championship, namely the contest to stay in the respective division. Furthermore, European soccer clubs compete for spots in the UEFA Champions League, adding yet another contest. These contests may increase the average appeal of season games in Europe and thus increase the consumers' willingness to pay therefore making European leagues more attractive for pay-TV broadcasters. However, it has to be noted that the North American post-season championship structure imposes similar "sub-contests" inexistent in European soccer leagues. In North America, there is a competition for the playoff spots. Subsequently, the championship is played out using a K.O. format which significantly increases the appeal of these games. While in Europe, it might well be the case that the champion is determined several match days prior to the season ending, thus decreasing the viewers interest in the remaining season, the champions in North American Major Leagues are determined but at the end of the season. Thus, even though there might be small differences in average appeal across the continents, and given the assumption that appeal matters for demand, these differences are negligible. Secondly, institutional differences might play a role for the allocation of the broadcasting rights to the different types of broadcasters. Partial ownership of sports clubs by broadcasters could lead to "toeholds", yielding a significant advantage in certain auctions for broadcasting rights [Klemperer, 1998; Bulow et al., 1999; Harbord and Binmore, 2000]. The reason is that broadcasters with toeholds essentially pay less for broadcasting rights due to the fact that some fraction of the rights' value is redistributed to them as owners of clubs via league payout. Such toeholds also effectively reduce the winner's curse as non-toehold bidders are induced to reduce their bids. The question which then arises is whether broadcaster integration into sports clubs differs across continents regarding types of broadcasters. A glance at media ownership of sports clubs both in Europe and in the U.S. reveals that there is no need to assume that toeholds contribute substantially to the proliferation of pay-TV in Europe. While there exist pay-TV stations in Europe with partial ownership

of soccer clubs (e.g., BSkyB/Manchester United and NTL/Newcastle United in the U.K., Mediaset/AC Milan in Italy, Canal Plus/Paris St. Germain in France) there are similar instances in North America (DirecTV/L.A. Dodgers (via News Corporation), Comcast/Philadelphia 76ers). Nonetheless, pay-TV ownership of sports clubs remains somewhat lower in magnitude in North America as opposed to Europe. However, this might also be an implication of their relatively young existence. In Europe, pay-TV stations should have been in a similar position in their early years. Still, they were able to increase their market share considerably. Therefore, it seems to be reasonable to assume that toeholding does not possess a significant impact on the dichotomous development in pay-TV across the continents. Thus, in what follows, we will restrict ourselves to the three factors which are mentioned by Szymanski [2003].

While all of the above factors play a role in determining whether or not free-to-air or cable-TV stations are able to seize major sports broadcasting rights, we claim that an additional aspect that has not been given much importance in the literature is relevant for the league's decision: the preferences of league- and club-sponsors. Next to revenue from broadcasting rights, advertising and sponsorship income constitutes a main pillar of league income. Deloitte [2004] reports that sponsorship revenue accounts for 15% to 30% of total league revenue in European top soccer leagues. In Germany and France, sponsorship is the second most important source of revenue accounting for 30% and 20% respectively. The relevance of sponsorship income again implies that to the extent that sponsors' preferences are depending on characteristics of the broadcasting contracts, they will influence any rational league's decision who to sell the broadcasting rights to. The question of importance then is what the sponsors' preferences look like. Obviously, there are several goals that sponsors would like to see met [see Cornwell and Maignan, 1998, for an overview]. Gwinner [1997] points out that the most important goals of sponsors are increasing brand awareness and "establish, strengthen or change brand image" [Gwinner, 1997, 145]. While it might be the case that in order to achieve one of these goals, sponsors seek to maximize the homogeneity of the set of viewers of the sponsored event or league, it is clear that for increasing brand awareness, maximizing reach, i.e., the number of viewers, is desirable [Mason, 2005; Gwinner, 1997].[4] Of course, a high reach will be associated with a high sponsorship fee. This is the reason why advertising in the environment of mega-events such as the NFL's superbowl has traditionally been the most expensive. This positive relationship between reach and sponsorship fee also implies that sponsors will most likely care about the nature of a league's broadcasting contract and especially whether pay- or free-TV networks obtain the rights to broadcast the sponsored league. Therefore, any rational league will incorporate sponsors' reactions and thus changes in sponsoring revenue into the decision who to sell its broadcasting rights to.

While there are some models dealing with the possibilities of free- and pay-TV airings [Holden, 1993; Chae and Flores, 1998; Hansen and Kyhl, 2001], to our knowledge there exists no formal model incorporating preferences of sponsors and their effects onto decision-makers and the athletes determining the quality of the championship product. In this paper, we present a simple model of broadcasting rights sales and show that when league officials do not take sponsors' reactions into account then the league will always sell its rights to a pay-TV network. However, among other factors,

the probability of free-TV airing increases with an increasing importance of viewer ratings for sponsorship fees. The paper is organized as follows. In the next section we present the model. The third section provides some explanations why it might be in the interest of the leagues not to sell the broadcasting rights to subscription-TV networks in the U.S. as opposed to Europe. The fourth section addresses welfare issues and the fifth discusses policy implications that stem from the model. The final section concludes.

THE MODEL

Model Setup

We consider a league which is willing to sell the rights to broadcast any amount of league coverage exclusively to one network. Suppose there are two networks competing for the rights to cover league play, which especially include the right for live coverage of all games and might also include rights for highlight-shows and so forth. For the sake of simplicity, we will henceforth assume that the network obtaining the TV-rights holds all-encompassing rights regarding TV-coverage, i.e., it possesses full discretion with regard to the amount of coverage to be aired on its station. The fact that it holds these rights exclusively implies that the broadcasting network is a monopolist in a given market.[5] To model pay- and free-TV networks, we pursue a different strategy than Chae and Flores [2003] and assume that both pay- and free-TV network face identical inverse demand depending on price and the quality of the sports championship. The price then incorporates both direct monetary charges such as the subscription fee or cable-TV fees as well as viewers' disutility of watching commercials during a televised sports event. Note that our setup essentially is a special case of Chae and Flores [2003] corresponding to a demand function with linear nuisance function and adjusted parameters.[6] In order to differentiate pay- from free-TV networks, we assume that in contrast to the pay-TV station, the free-TV network cannot choose prices freely but is obliged to abide to a price cap. The latter is equivalent to a minimum quantity of sports broadcasting on free TV, where quantity refers to the number of viewers. It is assumed that this minimum amount is higher than the viewership that resulted in a private monopoly. This differentiation makes sense when considering the fact that free-TV stations cannot charge customers for the services other than through cable charges as it is the case both in the U.S. and in Europe. These charges are substantially lower than fees for subscribing to a pay-TV service. Additionally, regarding the airing of commercials, free-TV stations cannot act discretionary either. On the one hand, live sports broadcasts possess an upper bound to the amount of commercial airing determined by the natural breaks in the sport event. On the other hand, in some European countries, for example Germany and the U.K., cable-TV networks face tight restrictions on the quantity of commercials to be aired (see the third section for details). These stylized facts then legitimate a use of a price cap for the free-TV stations in the context of our model. Another factor contributing to the suitability of a price cap is the fact that in Europe most free-to-air networks are public companies, i.e., they are owned by the federal state and managed by persons

selected by government branches. While inexistent in the U.S., these public networks (e.g., ARD and ZDF in Germany, BBC in the U.K., TF1 in France and RAI in Italy) play an important role in their respective national markets.[7] Public broadcasters face even more restrictive advertising legislation than cable-TV networks implying that they are to abide to an even harder price cap.[8]

Note that while public ownership of broadcasters does not exist in North America, then notion of a price cap also applies to the North American free-TV networks, as regulators are able to affect advertising restrictions for all broadcasters. The pay-TV networks may compensate for such restrictions by increasing the subscription fee. However, free-TV networks do not have this possibility. Thus, even though some free-TV networks differ across continents regarding ownership structure, the notion of capped charges applies both to publicly and privately owned free-TV networks. In the case of the former, however, regulators possess a more direct possibility of affecting or restricting pricing decisions.

Returning to the model setup, suppose that the league body possesses the full rights to market any league-game via TV. The league is assumed to possess two major sources of income: The payment for the TV-rights and sponsorship fees from the league's main sponsors. League income is then given by:

$$\pi_L = t + \tau$$

where t denotes the value the league receives for the TV-package while τ represents sponsorship income. We assume that sponsorship income is an increasing function of total viewership, i.e., the quantity demanded on the market for TV-programs, that is, $\tau = \tau(q)$ with $\tau'(q)>0$. While we do not model sponsor behavior explicitly, we will henceforth assume that $\tau = \alpha + \beta q$, i.e., sponsorship deals incorporate a fixed fee, plus a variable fee increasing with the reach a sponsor achieves through broadcasting.

We suppose that both broadcasters are facing a linear inverse demand $p(q,y) = a - bq + dy$ where the consumers' willingness to pay is depending on total viewership q and the quality of the championship $y = y(e_1, e_2)$. The quality of the championship y is assumed to be some increasing function of club owners' investments into the team e_i, i=1,2.[9] Furthermore, we assume that the two clubs share the league prize, i.e., total league revenue, along the lines of a Nash-Bargaining-scheme.

The timing of events is as follows:

1. Networks compete for the TV-rights through a first-prize auction, league chooses buyer which generates highest aggregate revenue.

2. All club-owners choose their investment levels e_i, knowing that they share the league prize along the lines of Nash-Bargaining.

3. Winning network chooses broadcasting price and thus simultaneously total viewership of the sport.

4. Sponsors pay the league accordingly and payoffs in the broadcasting market are realized.

The solution to this model will crucially depend on two things: Firstly, the mechanism which passes total league income $\pi_L = t + \tau$ back to the clubs and, secondly, the exact nature of the bidding process used to allocate the right to broadcast the sport on TV. In what follows, both points will be briefly elaborated on.

Regarding revenue distribution from the league to the clubs, the standard mechanism in the sports economics literature is specific contest architecture along the lines of Tullock [1980]. This approach has proved useful in showing overinvestment tendencies which are observed in many sports leagues. However, few models have succeeded to incorporate endogenous revenues into the standard contest architecture in a satisfying manner. The reason for this is quite simple: Even though analytical solutions for the clubs' investment-levels exist, they tend to become fairly unmanageable. For this reason, researchers have either modeled the contest prize exogenously or have utilized some other mechanism distributing total league revenue among the clubs. The latter approach does not only make sense from a methodological viewpoint but from stylized facts. Both in the North American Major Leagues as well as in some European soccer leagues, the significance of revenue sharing has increased dramatically in recent years. In the German Soccer Bundesliga, 50% of total TV-revenue is split evenly among all clubs [Kruse and Quitzau, 2003]. In the league with the highest degree of revenue sharing, the NFL, 40% of gate revenue is split between the participating teams while revenues out of TV-contracts and merchandising are shared evenly among all teams [Easton and Rockerbie, 2005; Einolf, 2004]. This implies that only a small fraction of aggregate league revenue is distributed through end-of-year rankings. Thus, the vast majority of league revenue is distributed in a manner much more resembling of Nash-Bargaining than of Tullock-rent-seeking. This stylized fact, combined with the feature of endogenous revenues has made Nash-Bargaining the mechanism of choice in this paper. Note that this approach also reflects the fact that sports clubs in a given league are competitors on the pitch but engaged in a cooperative relation regarding affairs of league-wide concern.[10] Clubs' investment behavior is of non-cooperative nature while the transmission of the prize to the clubs emerges in a cooperative manner. However, it is unclear whether the results derived in this paper are robust to the distribution mechanism or whether a specific contest architecture were to alter these results.

Regarding the bidding process, it is important to note that TV-networks' bids will obviously depend on the specific nature of the broadcasting rights auction. Subsequently, club-behavior is affected by the bidding process, since revenue out of the broadcasting rights sale constitutes a significant part of league- and finally club-income. The bidding process is modeled as a first price sealed-bid auction with complete information. The outcome is equivalent to a second-prize sealed bid auction in which aggregate league revenue is considered as the bid. Whether, and if yes, how incomplete information on behalf of the bidders changes the outcome qualitatively is subject to future research. The fact that the broadcasting rights are auctioned using a first-price sealed-bid auction also dampens, if not eliminates, the potential effect of toeholds onto the allocation of rights-ownership as toeholds are predominantly relevant in ascending auctions, in which some of the opposing bidders' characteristics are private information. As Klemperer [1998] notes, "the first-price (sealed-bid) auction remains close to optimal when one player has a small advantage" [Klemperer, 1998, 764]. This does, of course, not imply that media ownership might not play a role in some aspects of the rights sale. However, the incorporation of partial club-ownership into the model is an extension reserved for future research.

EQUILIBRIUM

Stage 3

The two networks' behavior on the TV-market will differ due to the fact that the free-TV station has to abide to the price cap while the pay-TV network does not. We will first look at the case in which the pay-TV network (indexed with "P") holds the broadcasting rights and then analyze the situation in which the free-TV broadcaster (indexed with "F") is in possession of the rights.

Pay-TV Broadcaster. If the pay-TV broadcaster has obtained the rights in stage 1 for the fee t_P it will then solve the following problem in the broadcasting market:[11]

$$\max_q\{p(q_P, y)q_P - t_P\} = \max_q\{(a - bq_P + dy)q_P - t_P\}$$

resulting in monopoly pricing

$$(q_P, p_P) = (q^M, p^M) = \left(\frac{a + dy}{2b}, \frac{a + dy}{2}\right)$$

and gross profits[12]

$$\pi_P = \frac{(a + dy)^2}{4b}$$

Free-TV Broadcaster. Suppose that the free-TV broadcaster is obliged to set prices such that total viewership is at least $\hat{q}$. Such a constraint can be interpreted as a minimum quantity and is equivalent to a price cap. The minimum quantity will be higher than viewership in a monopolistic situation, i.e., $q^M < \hat{q} \equiv q^M + \varepsilon$, where $\varepsilon > 0$ may be chosen by policymakers. Then, due to the concavity of $\pi_i = (a - bq_i + dy)q_i - t_i$ with respect to q_i and its maximum at q^M the free-TV broadcaster will select

$$(q_F, p_F) = \left(q^M + \varepsilon, \frac{a + dy - 2b\varepsilon}{2}\right)$$

and generate gross profits of

$$\pi_F = \frac{(a + dy)^2}{4b} - b\varepsilon^2 < \pi_P \tag{1}$$

Standard backward induction would now result in proceeding to the analysis of club behavior in stage 2. The following lemma allows us to move directly to stage 1 in order to simplify the exposition.

Lemma 1. Given the timing of the model, the clubs' equilibrium effort levels (e_1^*, e_2^*) are independent of broadcasting rights ownership.

Proof. In the first price auction, the bidder generating the highest total league revenue wins the auction and pays the amount of his bid. Thus, the pay-TV network wins the auction if and only if $t_P + \tau_P > \pi_F + \tau_F$.[13] Since under complete information all relevant data is common knowledge, both stations will know the maximum bid of the other station.[14] Therefore, if the pay-TV network wins the auction, its bid t_p will be the minimum bid ensuring that $t_P + \tau_P > \pi_F + \tau_F$.[15] Its payment to the league will then be such that aggregate league revenue is equal to:[16]

$$\pi_F + \tau_F = \alpha + \frac{(a + dy_F)^2}{4b} + \frac{\beta(a + dy_F)}{2b} + \beta\varepsilon - b\varepsilon^2 \tag{2}$$

Conversely, it can be argued that if the free-TV broadcaster turns out to be the winner, total league revenue will be determined by the pay-TV network's potential maximum profit and sponsorship income:

$$\pi_P + \tau_P = \frac{(a + dy_P)^2}{4b} + \alpha + \frac{\beta(a + dy_P)}{2b} \tag{3}$$

The winning aggregate league revenues (2) and (3) imply that $t_P + \tau_P = t_F + \tau_F + \beta\varepsilon - b\varepsilon^2$. This again implies that when sharing the league prize in stage 2, the clubs will exert identical effort levels due to the fact that the league prizes differ only by an exogenous constant. Therefore, subsequent quality levels will be identical, i.e., it will be the case that $y_P = y_F \equiv y$, and thus, in equilibrium, rights ownership will not affect championship quality.[17]

The above lemma can be interpreted as a special case of Rottenberg's invariance proposition [Rottenberg, 1956]. The allocation of broadcasting rights does, in equilibrium, not affect the clubs' investment behavior, leaving competitive balance unchanged. Nonetheless, one has to be clear that Lemma 1 is not robust to alternative specifications of the price cap. Once the price cap is specified in relative terms, clubs' investment levels will depend on the ownership of the broadcasting rights.

Having shown that stage 2 effort-choices do not depend on the equilibrium-outcome of stage 1, we can now proceed with analyzing the league's network choice in stage 1. Note that the above result can also be obtained using standard backward induction.

Stage 1

The outcome of the bidding process is summarized in the following proposition:

Proposition 1. Given the bidding process and subsequent broadcasting profits, the free-TV network will obtain the rights to broadcast the championship if and only if

$$\varepsilon \leq \frac{\beta}{b} \tag{4}$$

The accompanying payment is given by $t_F^* = (a + dy)^2 / (4b) - \beta\varepsilon$. In all other cases, the pay-TV network obtains the TV-rights and its payment to the league is given by $t_P^* = (a + dy)^2 / (4b) - b\varepsilon^2 + \beta\varepsilon$.

Proof. See the Appendix.

The above proposition states that given a set of parameters, the probability of the free-TV broadcaster obtaining the rights will ceteris paribus increase with (i) a less restrictive price cap, (ii) a higher sensitivity of sponsorship revenue to viewer ratings and (iii) a lower sensitivity of the price in the broadcasting market with respect to the quantity demanded (i.e., a lower slope of the demand curve). The crucial issue in determining whether the free-TV network is able to secure the broadcasting rights is the comparison between revenue difference in the broadcasting and in the sponsoring markets. On the one hand, there is increased sponsorship revenue through a larger audience in free-TV; on the other hand, there is a greater flexibility of the pay-TV network regarding pricing decisions. The latter results in higher gross profits for the pay-TV network with which it may be able to compensate the league for the foregone sponsorship income.

As the price cap becomes less restrictive (i.e., ε decreases) the difference in profits between the free- and the pay-TV networks out of broadcasting decreases which again reduces the potential of the pay-TV network to outbid the free-TV station and simultaneously compensates the league for foregone sponsorship income. As the responsiveness of sponsorship income with regard to total viewership increases (i.e., β increases), the effect of higher viewer ratings on sponsorship income increases and thus the probability that the pay-TV network can outbid the free-TV network and simultaneously compensate the league decreases. A decrease in b results in higher demand at any given price. Since it also affects the free-TV network's price, the gross profit difference $\pi_P - \pi_F$ will be reduced. Therefore, the ability of the free-TV network to outbid the pay-TV broadcaster increases.

Aggregate league revenue is given by

$$t_F^* + \tau_F = \alpha + \frac{(a + dy)(a + dy + 2\beta)}{4b}$$

if the free-TV network wins the contract, that is, if $\varepsilon \leq \beta/b$ and

$$t_P^* + \tau_P = \alpha + \frac{(a + dy)(a + dy + 2\beta)}{4b} - b\varepsilon^2 + \beta\varepsilon$$

otherwise, i.e., if $\varepsilon > \beta/b$. The broadcasters' net profits are given by:[18]

$$(\pi_P^j, \pi_F^j) = \begin{cases} (0, \beta\varepsilon - b\varepsilon^2) & \text{if } \varepsilon \leq \dfrac{\beta}{b} \Leftrightarrow j = F \\ (b\varepsilon^2 - \beta\varepsilon, 0) & \text{otherwise} \end{cases}$$

Since the focus of the paper lies in the optimal allocation of the broadcasting rights and—as shown in Lemma 1—the allocation of rights does not alter club-behavior, we have relegated the calculation of club profits to the Appendix.

BROADCASTING IN EUROPE VERSUS THE U.S.

As shown in the previous section, the league tends to endow the free-TV network with the broadcasting rights if (i) the price cap is not too restrictive, (ii) sponsorship fees are sufficiently sensitive to total viewership and (iii) consumers in the broadcasting market are sufficiently price sensitive. The question that remains is why in Europe professional sports is migrating to pay-TV while in the U.S. this is not the case.

As has already been argued, the literature [see Szymanski, 2003; quoted in Hoehn & Lancefield, 2003] has provided some arguments which help explain this dichotomous development across the two continents. Most of the arguments fit nicely into the model derived above. Szymanski [2003] points out to the fact that in the U.S., there exist several major sports generating a high amount of demand. In Europe, however, soccer is the sport with the highest demand by far. Szymanski [2003] concludes that the existence of other sports may indeed make consumers more sensitive to price in the sense that substitution effects from one Major League sport to another may be existent. This is fully in line with our model. Here, a higher degree of price sensitivity of U.S. TV-sports consumers than their European counterparts corresponds to a lower b which ceteris paribus then again implies that the upper bound for the minimum quantity such that the free-TV network obtains the broadcasting rights is higher. Thus, given some set of parameters (β,ε) it is more probable that North American Major Leagues cede their rights to a free-TV broadcaster if indeed substitution effects in the U.S. are more important than in Europe.

In the context of our model, the argument that the U.S. Federal Communications Commission (FCC) legislation has put up barriers to entry for pay-TV stations in the U.S. market can be interpreted as a low price cap for free-TV networks in North America such that they can effectively compete with pay-TV stations. A policy in this direction, for example the reduction of advertising restrictions for free-TV stations, would increase free-TV networks' bidding possibilities and thus the possibility for major sports broadcasts to be aired via free-TV. Indeed, it is the case that U.S. legislation regarding advertising is far less restrictive than in Europe. The Mass Media Bureau [1999] reports that in the U.S., excepting children's programs there are no restrictions to the amount of advertising that a station may broadcast. In Germany, however, there are strict limitations as to the amount and type of advertising to be aired per day and per hour. There is a daily maximum of 15% advertising and an hourly maximum of 20% [see Rundfunkstaatsvertrag, 2004, §45]. Additionally, there are strict restrictions such as minimum lengths on the practice of breaking programs in order to fill the gaps with advertising [Rundfunkstaatsvertrag, 2004, §44]. Restrictions for public broadcasters are even tighter. Similar restrictions are present in the U.K. [Ofcom, 2005]. In this light, it is fair to say that at least in Germany and the U.K., legislation on advertising is far stricter than in the U.S., which makes our model's predictions consistent with the argument of higher barriers-to-entry for pay-TV stations in the U.S.

An additional aspect that adds to a lowered price cap for free-TV networks in the U.S. stems from the type of sports broadcast. In Europe, soccer constitutes the predominant TV-sport. A soccer match consists of two respectively uninterrupted halves of 45 minutes which are separated by a 15 minute half-time break. This half-time break thus is the primary interval in which networks are able to air commercials without causing very high disutility for viewers. The North American Major League sports however, i.e., Basketball, Football and Baseball, are interrupted significantly more often, on the one hand, due to the fact that they are segmented into thirds, quarters or ninths, on the other hand, due to the fact that coaches can call timeouts in which play is halted for a short time period allowing networks to run commercials. In the NBA, there is a total of 8 timeouts per team, some of them mandatory, plus the breaks between quarters adding to a total potential commercial time significantly exceeding the 15 minutes in soccer. Similar calculations can be made for the other Major League sports. This excess of advertising possibilities for North American Major League sports relative to soccer can be interpreted as an additional factor that leads to a reduced price cap for U.S. broadcasters.

Economies of scale issues are not addressed directly by our model. Since we have neglected both fixed and variable costs, market size will play no role whatsoever in determining the winning broadcaster, i.e., no pan-European broadcaster bidding for several national rights will—on aggregate—possess any advantage over national networks bidding for domestic broadcasting rights.[19] However, once fixed costs are introduced, economies of scale arise. Assuming that fixed costs are constant and independent of market size, the pan-European conglomerates will possess a larger bidding cushion than at least some national broadcasters. In such a case, pan-European pay-TV networks' potential to compensate the league for foregone sponsorship income relative to the national networks will be higher. To see this, suppose that there are N European markets all facing the inverse demand given by $p(q,y) = a - bq + dy$. Additionally, assume that any broadcaster entering a positive number of markets faces fixed costs of F independent of the number of markets that it is entering. Next, suppose that the free-TV broadcaster is constrained to one market while the pay-TV network can operate in $n \geq 1$ markets. Then, following the proof of Proposition 1 in the Appendix, the free-TV station will be able to obtain the broadcasting rights for its domestic market, if and only if[20]

$$b\varepsilon^2 - \beta\varepsilon + F\left(1 - \frac{1}{n}\right) \leq 0 \tag{5}$$

Note that for $n = 1$ condition (5) is equivalent to condition (4). However, for $n > 1$ —i.e., an increasing relevance of economies of scale—it is the case that $F(1 - 1/n) > 0$ and thus, for some given set of parameters, it is less probable that the domestic free-TV network obtains the broadcasting rights than in the absence of a pan-European pay-TV broadcaster.

The question which then arises is whether it is indeed the case that, other than free-TV networks, pay-TV networks operate on a pan-European basis and can exploit

economies of scale that free-TV broadcasters cannot. A brief glance at the ownership structure of European networks reveals that there is no reason to assume so. There are several pay-TV stations operating primarily in one country (e.g., Premiere in Germany, Mediaset in Italy) and while there also are pay-TV conglomerates operating in several countries (e.g., Rupert Murdoch's News Corporation via Sky in the U.K. and in Italy, Canal Plus in France, Spain and the Netherlands) there conversely are free-TV networks broadcasting in several countries (first and foremost the RTL Group controlling 32 channels in 11 countries). In this light, it seems to be the case that in Europe, pay- and free-TV networks possess identical possibilities to exploit pan-European economies of scale implying no advantage for pay-TV networks to outbid free-TV stations on these grounds. However, it has to be noted that public free-TV stations which can be legally restricted to enter markets other than their domestic market do not possess the same possibility to exploit economies of scale as the private free- and pay-TV networks. To the extent that the public networks play an important role in national markets, which in some countries they do, pan-European networks may be able to outbid the networks on grounds of economies of scale. However, these pan-European networks may either be of free- or pay-TV nature.

A final reason fostering the dichotomous development of spectator sports coverage in the U.S. and Europe might lie in different perceptions of the dynamic properties of the model. To see this, suppose that the parameter β incorporates a discount factor, in the sense that

$$\tilde{\beta}_k \equiv \rho_k \beta, \qquad k \in \{US, EU\}$$

and

$$\rho_k \equiv \frac{1}{1+\sigma_k}$$

where σ_k denotes area k's time preference rate. Then, it is straightforward that condition (4) will be replaced by

$$\varepsilon \leq \frac{\tilde{\beta}_k}{b} \tag{6}$$

Now, suppose that European sports leagues do not care about future income streams at all, i.e., $\sigma_{EU} \to \infty$ and therefore $\tilde{\beta}_{EU} = 0$. In such a case, the league will not care about sponsoring income implying that for $\varepsilon > 0$ the pay-TV station will always be able to outbid the free-TV network and thus seize the broadcasting rights. A high degree of discounting might be one explanation for not taking sponsorship income into account and causing pay-TV airing of the sports event. Another possibility is that European league bodies do not behave in a rational manner and thus do not anticipate sponsors' reactions to viewer ratings. These assertions, though somewhat far-fetched, might be justified if we look at the organizational structure and the degree of professionalism in league management across the continents. North American

Major Leagues are organized as cooperatives which are jointly owned and managed by the participating clubs' owners. In Europe, however, soccer league organization still possesses many characteristics that stem from the development out of national association structures.[21] The associated different degrees of professionalism might imply somewhat different perceptions of future income streams. While the assertion that European league bodies do not incorporate future sponsoring income at all might be somewhat extreme, it could very well be the case that European leagues discount future income streams more heavily than their North American counterparts implying that $\tilde{\beta}_{EU} < \tilde{\beta}_{US}$. For a given set of parameters (ε', b') this would make a free-TV airing in the U.S. more probable since it is the case that $\tilde{\beta}_{EU} / b' < \tilde{\beta}_{US} / b'$.

In short, our model is fully consistent with the stylized facts discussed in the literature. Additionally, it stresses the role of sponsorship contracts and leagues' discount rates for the predominance of pay- or free-TV sports broadcasting. Having now positively analyzed the equilibrium outcome of the model in terms of possible reasons for pay- or free-TV broadcasts we will turn to the normative question of which of the two is "better" in terms of welfare. Subsequently, we will discuss policy implications stemming from welfare analysis.

WELFARE

Before deriving the welfare-maximizing allocation $(e_1^{FB}, e_2^{FB}, q^{FB})$, one has to become clear about what first-best refers to in the context of the model presented above. By definition, a first-best situation is characterized by the maximum value of aggregate profits of all players involved. In our model, these aggregate profits include the networks' profits out of broadcasting, consumer surplus and the league's sponsorship income net of clubs' investment costs.[22] Adopting this view, the first-best investment levels are summarized in the following proposition.

Proposition 2. Given the structure of the market as described above, the welfare maximizing club-effort levels (e_1^{FB}, e_2^{FB}) and network broadcasting quantity q_{FB} are given by

$$(e_1^{FB}, e_2^{FB}) = \left(\frac{d(a+\beta)}{2bcr - d^2(1+r)}, \frac{dr(a+\beta)}{2bcr - d^2(1+r)} \right)$$

$$q^{FB} = \frac{2cr(a+\beta)}{2bcr - d^2(1+r)}.$$

Proof. See the Appendix.

Interestingly, the first-best allocation implies a negative price of viewing the championship via television:[23]

$$p(q^{FB}, y(e_1^{FB}, e_2^{FB})) = a - bq^{FB} + d(e_1^{FB} + e_2^{FB}) = -\beta < 0 \tag{7}$$

This is the case because marginal costs of broadcasting are zero and the positive impact of sponsorship income on welfare implies that marginal costs of broadcasting are effectively negative. In other words, the resulting welfare loss in the broadcasting market out of "selling" the championship on TV at a negative price is compensated by the increased sponsorship income by the league due to the high amount of viewership. Of course, the implementability of such an allocation might prove somewhat difficult. Note that in case sponsorship income is independent of viewer ratings (e.g., $\beta = 0$), condition (7) implies standard marginal cost pricing in first-best. Using straightforward algebra, it can be shown that in equilibrium clubs' efforts, championship quality and total viewership are lower than in a first-best setting.[24] The main reason for this observation is that in equilibrium, the network obtaining the TV-rights will behave in a monopolistic manner in the broadcasting market thus imposing a monopolistic deadweight loss. The question then arising is whether and, if yes, how policymakers might influence the equilibrium outcome in order to distort the equilibrium outcome towards the first-best outcome. We will address this question in the next section.

POLICY IMPLICATIONS

In the light of the issues discussed above, the question is what can policymakers do in order to induce an equilibrium outcome with increased welfare. In terms of our model, the parameters under scrutiny are β, b, and ε. Assuming that both sponsorship contracts and the elasticity of demand in the broadcasting market are out of the policymakers' reach leaves the price cap ε as the variable of action. Now, recall that in equilibrium, the clubs' effort levels and subsequently the quality of the sports event are independent of TV-rights allocation. This implies that in order to increase welfare, policies must be directed at maximizing viewership q.[25] It has already been shown that a more restrictive price cap (i.e., a higher ε) ceteris paribus increases the probability that the pay-TV network obtains the broadcasting rights and then sets the monopolistic viewer quantity q^M. When abolishing the price cap, policymakers will be able to induce the league to cede the rights to the free-TV station. However, once in possession of the broadcasting rights, the free-TV network will behave in a monopolistic manner thus leaving welfare unchanged. Therefore, policymakers should set the price cap to the maximum amount still guaranteeing that the free-TV network obtains the broadcasting rights, i.e., $\varepsilon = \beta/b$. Such a cap would maximize viewership q given the networks' subsequent optimizing behavior. If government funding is available, the government could subsidize the free-TV network (which also happens in practice in the case of the public stations in Europe) in order to improve the network's bidding leeway and conversely set a high price cap (ideally such that $p(\tilde{q}, y(e_1^*, e_2^*)) = 0$) such that a perfectly competitive outcome is replicated. One has to be clear, however, that taxation in order to obtain the funds needed for subsidization induces a deadweight loss again yielding adverse effects on welfare.

Still, this points to another lever for increasing welfare. The model presented above assumes that there are but two networks and that broadcasting rights are allocated to a single network. Welfare analysis has shown, in turn, that welfare is maximized at a price lower than marginal cost. This implies that policymakers could also try to

improve possibilities for entry into the sports broadcasting market and foster competition in this market. In case of perfect competition, no network would be able to bid for the broadcasting rights leaving no choice to the league but to cede its rights to all competitors at no cost in order to maximize viewership and subsequent sponsorship income. While such a situation is not equivalent to first best, it constitutes a second-best situation in terms of a situation still being implementable in the absence of transfer payments from the league to the TV-networks. However, it has to be noted that the championship prize in such a setting may be lower than in the equilibrium derived in Proposition 1.[26] If this were the case, then the clubs' effort levels would be lower than in equilibrium resulting in a lower quality of the championship, a subsequently lower viewership $\tilde{q}$ and finally lower sponsorship revenue. The aggregate effect on welfare then is ambiguous; a sufficient condition for an improvement of welfare in perfect competition relative to the equilibrium derived in Proposition 1 is that[27]

$$\beta(4bcr - d^2(1+r)) - 4abcr > 0. \tag{8}$$

CONCLUSION

The questions addressed in this paper are why sports programming in the U.S. is primarily occurring through free-TV as opposed to pay-TV in Europe and which type of broadcast is preferable from a welfare point of view. The model presented to shed light on these questions consists of a free-TV and a pay-TV network where the free-TV station is constrained regarding pricing decisions. The model shows that the probability of free-TV airing of major sports increases with (i) a less restrictive price cap, (ii) a higher sensitivity of sponsoring fees to viewer ratings and (iii) a higher price sensitivity of consumer demand. We have argued that the model is consistent with previous explanations in the literature which stated that free-TV sports broadcasts in the U.S. are predominantly due to (i) the existence of larger substitution effects due to the availability of more than one major sport, (ii) economies of scale of free-TV stations due to the larger national market and (iii) FCC legislation which is acting as a disincentive for pay-TV entry. Subsequently, we have argued that differences in discounting across the two continents may be an additional explanation resulting in pay-TV being the networks of choice in Europe. If the revenue streams of sponsors materialize in periods later than the league's decision as to whom to sell the broadcasting rights, then discounting will obviously be a relevant factor.

We have also discussed the robustness of the findings to the specifications used in the model. The choice of Nash-Bargaining to pass league revenue to the clubs and the fact that the bidding process is modeled as a first-price-auction with complete information both might be crucial for the results derived above. The condition determining whether the broadcasting rights are allocated to the free- or pay-TV network in equilibrium is robust regarding the functional forms of the clubs' effort costs and championship quality. This is due to the fact that clubs' effort levels are independent of broadcasting rights ownership. The latter, however, is crucially depending on the additive nature of the minimum quantity the free-TV networks are required to show.

Once this minimum quantity is specified in relative terms, the clubs' effort levels and thus the quality of the championship will be depending on the league's network choice and will therefore again influence the networks' bidding behavior. An extension of this model has to certainly take all of these issues into account and is subject for future research.

A normative analysis has shown that in order to improve welfare, regulators need to facilitate policies directed to increasing the viewership of sports broadcasts. In the presented two-network-framework this implies that the minimum viewership for free-TV stations should be the maximum amount still ensuring that the free-TV network obtains the broadcasting rights. Such a policy maximizes viewership while leaving the other determinants of welfare unchanged. When stepping to the broader picture, policymakers could also try to foster competition in the sports broadcasting market. While such action would have strong distributional effects, under certain circumstances it is preferable from an allocative point of view.

Even though European live soccer has almost entirely disappeared from free-TV, recent events in Germany point to an increased awareness of at least the German league body (DFL) regarding sponsors' preferences and their interdependence with broadcasting issues, i.e., viewer ratings of sports programming. There, Arena, a pay-TV joint-venture of local cable operators, bought the exclusive rights to broadcast the German soccer Bundesliga live from 2006 to 2009 for an annual fee of €250 million. While this is not further surprising, the interesting part is that Premiere, a large pay-TV network which, in contrast to Arena, already possesses a large number of subscribers, placed a bid of €280 million p.a. but was not endowed with the broadcasting rights. The problem was that Premiere insisted that the first highlight show on free-TV must not be aired before 10 p.m. while Arena owners did not oppose the traditional show at 6 p.m. Thus, for Premiere, the larger degree of exclusivity was worth an annual €30 million. However, DFL managers stressed that the later airing of the highlight show would not have been in the interest of sponsors [see Neue Zuercher Zeitung, 2005]. In the framework of our model this implies that the yearly €30 million seem not to be enough to offset income reduction incurred out of sponsorship due to the reduced viewership of the popular highlight show.

From the viewpoint of welfare, such insights from European league managers are of course welcome. Whether this awareness spills over to other leagues or might even go further than highlight shows remains to be seen.

APPENDIX

Proof of Proposition 1

Let us look at the optimization of, say, the pay-TV broadcaster which will minimize its bid subject to an outbidding constraint and a budget constraint. The former ensures that the network obtains the contract; the latter ensures that the bid is non-negative and the network does not incur losses. Obviously, the problem will then break down to the question whether the pay-TV network can afford to outbid the free-TV network.

The pay-TV broadcaster thus solves:

$$\min_{t_P}\{t_P\} \tag{9}$$

$$\text{such that } t_P + \tau_P > \tau_F + \max\{t_F\} \tag{10}$$

$$0 \le t_P \le \pi_P + t_P = \frac{(a+dy)^2}{4b} \tag{11}$$

Recalling that $\max\{t_F\} = \pi_F = (a+dy)^2/(4b) - b\varepsilon^2$, constraint (10) can be rewritten as

$$t_P > \frac{(a+dy)^2}{4b} - b\varepsilon^2 + \beta\varepsilon \tag{12}$$

If we assume that $(a+dy)^2/(4b) - b\varepsilon^2 > 0$ which implies that the free-TV network is to make positive profits if its bid is equal to zero, constraints (10) and (11) combined imply that

$$\frac{(a+dy)^2}{4b} - b\varepsilon^2 + \beta\varepsilon < t_P \le \frac{(a+dy)^2}{4b} \tag{13}$$

Thus, in order for the pay-TV broadcaster to win the auction, it must be the case that

$$\beta\varepsilon - b\varepsilon^2 < 0 \Leftrightarrow \varepsilon > \frac{\beta}{b} \tag{14}$$

If this were not the case, then the pay-TV broadcaster's maximum bid would not be high enough to compensate the league for the foregone sponsorship income resulting from the reduced viewership relative to the free-TV network. The solution to the above problem (9) is the minimum bid consistent with (13). For the sake of completeness, it has to be noted that this solution does technically not exist. We will still assume —with some handwaiving—that the solution t_P^* to the above problem (9) is given by $t_P^* = (a+dy)^2/(4b) - b\varepsilon^2 + \beta\varepsilon$ if condition (14) holds. By analogous reasoning, it can be shown that for the free-TV network to be endowed with the broadcasting rights, it must be the case that $\varepsilon \le \beta/b$. The free-TV network's bid will then be given by $t_F^* = (a+dy)^2/(4b) - \beta\varepsilon$.

Derivation of Equilibrium Profits

Free-TV Network Obtains Rights, $\varepsilon \le \frac{\beta}{b}$

In case the free-TV network obtains the rights to broadcast the championship, total league revenue is given by

$$t_F^* + \tau_F = \alpha + \frac{(a+dy)(a+dy+2\beta)}{4b} \tag{15}$$

which is to be shared equally among the participating clubs. Note that we could also allow for asymmetric payouts. However, this would overload the model while not providing any further insight on the sponsorship issue. Asymmetry among clubs is incorporated via effort costs. Effort costs are assumed to be convex and are given by ce_2^2 for club 2 and rce_1^2 for club 1 where $r \in (0,1]$.[28] For computational simplicity, we have also assumed that $y(e_1,e_2) = e_1 + e_2$. Then, club 1 solves

$$\begin{aligned} &\max_{e_1}\left\{\frac{1}{2}(t_F^* + \tau_F) - rce_1^2\right\} \\ &= \max_{e_1}\left\{\frac{1}{8b}\left[4b\alpha + (a + d(e_1+e_2))(a + d(e_1+e_2) + 2\beta)\right] - rce_1^2\right\} \end{aligned} \tag{16}$$

while club 2 analogously solves

$$\begin{aligned} &\max_{e_2}\left\{\frac{1}{2}(t_P^* + \tau_P) - ce_2^2\right\} \\ &= \max_{e_2}\left\{\frac{1}{8b}\left[4b\alpha + (a + d(e_1+e_2))(a + d(e_1+e_2) + 2\beta)\right] - ce_2^2\right\} \end{aligned} \tag{17}$$

Solving the system of reaction functions obtained through the respective first-order conditions (FOC) yields the equilibrium effort levels (e_1^*, e_2^*):

$$(e_1^*, e_2^*) = \left(\frac{d(a+\beta)}{8bcr - d^2(1+r)}, \frac{dr(a+\beta)}{8bcr - d^2(1+r)}\right) \tag{18}$$

Note that for the system of reaction functions to possess the unique solution (e_1^*, e_2^*), it must be the case that $8bcr - d^2(1+r) \neq 0$. Additionally, as will be shown in this Appendix, the existence of a welfare maximizing allocation requires that $2bcr - d^2(1+r)$ be positive, implying that $e_1^*, e_2^* > 0$. This could also be shown directly using non-negativity constraints.

The resulting profits of all players involved are summarized below:

$$\pi_1^F = \frac{\alpha}{2} + \frac{(8bcr - d^2)\left[acr(a+2\beta) + \frac{d^2\beta^2}{8b}(2r+1)\right] - \frac{d^4\beta^2 r}{8b}}{[8bcr - d^2(1+r)]^2} \tag{19}$$

$$\pi_2^F = \frac{\alpha}{2} + \frac{(8bc - d^2)acr^2(a+2\beta) + d^2\beta^2 cr(r+2) - \frac{d^4\beta^2(1+r)^2}{8b}}{[8bcr - d^2(1+r)]^2} \tag{20}$$

$$(\pi_P^F, \pi_F^F) = (0, \beta\varepsilon - b\varepsilon^2). \tag{21}$$

Pay-TV Network Obtains Rights, $\varepsilon > \dfrac{\beta}{b}$.

By Lemma 1, the equilibrium effort levels (e_1^*, e_2^*) remain unchanged from equation (18). The accompanying profits are summarized below:

$$(\pi_1^P, \pi_2^P) = \left(\pi_1^F + \frac{1}{2}(\beta\varepsilon - b\varepsilon^2), \pi_2^F + \frac{1}{2}(\beta\varepsilon - b\varepsilon^2) \right) \tag{22}$$

$$(\pi_P^P, \pi_F^P) = (b\varepsilon^2 - \beta\varepsilon, 0) \tag{23}$$

where π_i^F refers to the profits in case the free-TV network obtains the broadcasting rights as given in equations (19) and (20).

Proof of Proposition 2

The social planner's problem amounts to

$$\begin{aligned} & \max_{e_1, e_2, q} W(q, y(e_1, e_2)) \\ = \; & \max_{e_1, e_2, q} \left\{ p(q,y)q + \frac{1}{2}\left[p(0,y) - p(q,y) \right] q + \alpha + \beta q - rce_1^2 - ce_2^2 \right\} \qquad (24) \\ = \; & \max_{e_1, e_2, q} \left\{ \alpha - \frac{bq^2}{2} + q(a + \beta + d(e_1 + e_2)) - rce_1^2 - ce_2^2 \right\} \end{aligned}$$

Note that for the objective function to possess a unique maximum it must be the case that the Hessian H of $W(q, y(e_1, e_2))$ with respect to (e_1, e_2, q) is negative definite. The Hessian is given by

$$H = \begin{pmatrix} -2rc & 0 & d \\ 0 & -2c & d \\ d & d & -b \end{pmatrix} \tag{25}$$

Then, H is negative definite iff

$$-2rc < 0 \tag{26}$$

$$\begin{vmatrix} -2rc & 0 \\ 0 & -2c \end{vmatrix} = 4rc^2 > 0 \tag{27}$$

$$\begin{vmatrix} -2rc & 0 & d \\ 0 & -2c & d \\ d & d & -b \end{vmatrix} = -2rc(2bc - d^2) + 2cd^2 < 0 \tag{28}$$

$$\Leftrightarrow 2bcr - d^2(1 + r) > 0 \tag{29}$$

The first two inequalities are true if the parameters r and c are positive which is the case by assumption. Thus, for a unique global welfare maximizing allocation to exist, it must be the case that $2bcr - d^2(1+r) > 0$.[29] The reason for this is the positive and non-concave effect of consumer surplus onto welfare. The above condition ensures that the convex interaction effect of consumer surplus onto welfare does not outweigh the concave effects via costs and demand.[30] Returning to the social planner's problem, the corresponding system of FOC is given by

$$\frac{\partial W}{\partial e_1} = dq^{FB} - 2rce_1^{FB} = 0 \tag{30}$$

$$\frac{\partial W}{\partial e_2} = dq^{FB} - 2ce_2^{FB} = 0 \tag{31}$$

$$\frac{\partial W}{\partial q} = -bq^{FB} + a + \beta + d(e_1^{FB} + e_2^{FB}) = 0 \tag{32}$$

the solution of which yields

$$(e_1^{FB}, e_2^{FB}) = \left(\frac{d(a+\beta)}{2bcr - d^2(1+r)}, \frac{dr(a+\beta)}{2bcr - d^2(1+r)} \right) \tag{33}$$

$$q^{FB} = \frac{2cr(a+\beta)}{2bcr - d^2(1+r)} \tag{34}$$

Derivation of condition (8)

In perfect competition, no broadcaster will make positive profits; therefore league revenue is comprised of sponsorship income alone, that is $t^{PC} + \tau^{PC} = \tau(q^{PC}) = \alpha + \beta q^{PC}$. Marginal cost pricing implies that

$$p(q,y) = a - bq^{PC} + dy^{PC} = 0 \Leftrightarrow q^{PC} = \frac{1}{b}(a + dy^{PC}) \tag{35}$$

Plugging $t^{PC} + \tau^{PC}$ into the clubs' optimization problems (16) and (17) and solving the resulting system of FOC yields:

$$(e_1^{PC}, e_2^{PC}) = \left(\frac{d\beta}{4bcr}, \frac{d\beta}{4bc} \right) \tag{36}$$

Next, recall that $q^M(e_1^*, e_2^*) < q^{FB}$ as well as $e_i^* < e_i^{FB}$ for $i = 1, 2$. It can be shown using straightforward algebra that $q^M(e_1^*, e_2^*) < q^{PC} < q^{FB}$ and $e_1^{PC} < e_1^{FB}$. Then, because W is concave in all three arguments (recall that it's Hessian is negative definite over the whole support), welfare in perfect competition is higher than in the competitive equilibrium, if

$$e_i^{CE} < e_i^{PC}$$

$$\Leftrightarrow \frac{a+\beta}{8bcr - d^2(1+r)} < \frac{\beta}{4bcr} \tag{37}$$

$$\Leftrightarrow \beta(4bcr - d^2(1+r)) - 4abcr > 0 \tag{38}$$

In case the free-TV network possesses the broadcasting rights, condition (37) is sufficient, too. It follows from Lemma 1 that the demand curve in the broadcasting market is independent of rights ownership. However, due to the fact that $e_i^* < e_i^{FB}$ for $i = 1, 2$, the demand curve in first best is farther away from the origin than in equilibrium. This observation combined with the corresponding negative price in first best implies that viewership is higher since $q^M(e_1^*, e_2^*) + \varepsilon$ must be at a positive price for the free-TV network not to be outbid. Thus, the same argumentation as in the pay-TV case applies.

NOTES

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1. See Table 1.
2. Note that some of these models allow for a pay TV station to air commercials for an additional source of financing. In such a setting, obviously, pay-TV can never be worse than free- TV in terms of profits or welfare, as the former is always able to emulate the latter by setting a subscription fee of zero.
3. According to their own information, DISH has 12 million and DirecTV 11.1 million subscribers (as of January 2006 and October 2004 respectively) compared to 110 million TV-households in the U.S.
4. For a practical example see Marketing Week [2004] where Hong Kong Shanghai Bank (HSBC) states that they "became involved with sponsoring Formula 1 motor racing because of the large reach of the sport [...]" and that "from a sponsor's point of view, viewing figures are crucial" [Marketing Week 2004, 7].
5. As Table 1 shows, at least in Europe live coverage of national soccer leagues is always exclusive. If this were not the case, the value of the broadcasting rights would of course decrease significantly.
6. Chae and Flores [2003] differentiate pay- and free-TV networks by postulating that free-TV stations cannot charge a price but viewers have to endure advertising. The nuisance function then captures the viewers' disutility of advertising in a given program.
7. According to ARD [2005, 383], in 2004 the German public networks had an average (over 24 hours) market share of 41.7% in Germany. Similarly, BBC [2005, 138] reports a market share of 36.2% for all its stations in the U.K.
8. In Germany, the public networks are not allowed to air any commercials after 8 p.m. The British BBC is not permitted to air commercials at all.
9. For expositional simplicity we assume that $y(e_1, e_2) = e_1 + e_2$, that clubs' effort costs are convex and that club 1 possesses a cost advantage over club 2, i.e., $c_1(e_1) = rce_1^2$, $c_2(e_2) = ce_2^2$, with $r \in (0, 1]$. Note that the functional forms are not crucial for the central result of this paper, i.e., condition (4).
10. The latter aspect is also embedded in the organizational structure of many professional sports leagues both in North America and in Europe.
11. Assuming costs for televising programs are zero.
12. Subsequently, we will refer to direct profits out of broadcasting as "gross profits". Net profits are then given by gross profits minus the payment t_i for the broadcasting rights.
13. It is assumed that in case of indifference, TV-rights are allocated to the free-TV network.
14. We assume that neither network can incur positive losses.
15. It has to be noted that this minimum bid does technically not exist. We will still assume—with some handwaiving—that aggregate reveneue is given by $\pi_F + \tau_F + \nu$ with $\nu \to 0$.
16. See the Appendix for a formal derivation of the bids.
17. This is crucially depending on the specific nature of the free-TV broadcaster's price cap. This issue will be discussed further below in the Conclusion section.
18. The index $j = F,P$ refers to the winner of the auction. Note that $\pi_i^j = 0$ for $i \neq j$ and $\pi_i^i = \pi_i - t_i^*$.
19. The term "on aggregate" has been introduced since it is possible that a pan-European network can cross-subsidize between national markets which national broadcasters cannot.

20. This condition has been derived under the assumption that the pan-European pay-TV broadcaster is unable to cross-subsidize between national markets.
21. For an elaboration of these points see, for example, Szymanski [2003].
22. Note that whatever amount some network pays to the league is merely a transfer. Note also that we have not modelled the sponsors' preferences explicitly implying that sponsoring income yields a positive welfare effect. This can be justified by assuming that sponsors' utility out of sponsoring the league is given by $w\tau(q)$, where $w \geq 1$. The following analysis is then equivalent to the case in which $w = 1$.
23. Note that this result is consistent with Chae and Flores [2003].
24. In case of the free-TV network obtaining the TV-rights in equilibrium, this assertion is true only for ε sufficiently small.
25. Recall from the Appendix that the welfare function is concave in all arguments.
26. Note that in case of perfect competition $t_i^* = 0$ for all networks and therefore the league prize would be comprised of sponsorship income only again having effects onto clubs' effort levels and quality.
27. See the Appendix for a derivation of this condition.
28. We have assumed the league to consist of 2 teams. All results are robust to the number of teams.
29. Note that this condition also ensures that the effort levels in the competitive equilibrium (e_1^*, e_2^*) are positive.
30. In this light, it is a mere regularity condition.

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